

## Proposal of Sustainable and Eco-exurban Communities at the Western Desert Development Corridor in Egypt

Ahmed ELSEAGY, Amira ELNOKALY

*Department of Architectural Engineering and Environmental Design,  
Arab Academy for Science and Technology – AAST, Alexandria, Egypt.*

### Abstract

Worldwide energy assessments now indicate that improving the energy efficiency and sustainability of buildings, and urban communities could save our planet and free-up enormous amounts of current energy expenses. In addition, greater reliance on sustainability offers countries worldwide means of maintaining economic growth and environmental quality. In this rapid-urbanizing world, cities hold the key to achieving a sustainable balance between the Earth's resources and its human needs. Industrialization in developing countries has led to urban health problems on an unprecedented scale. Cities around the world affect not just the health of their people but the health of the planet. Urban areas take up very diminutive percentage of the world's surface but consume the bulk of vital resources. This research paper represents a holistic proposal which primarily aims to lessen the harm *poorly designed urban communities and buildings* in Egypt's big cities like Cairo and Alexandria cause. It draws attention towards exurban developments that are able to use the best of eco-building approaches in logical combination with the best of technological advances and renewable energy resources. The ultimate goal of this proposal is to put forward a sustainable-oriented development to make possible homes, offices, even entire subdivisions of suburban and exurban for newly proposed Egyptian communities away from the narrow-valley along the Nile and towards the **Western Desert Development Corridor WDDC** that are net *producers* of energy, food, clean water and air, beauty, and healthy human and biological communities. This paper proposes the methodology that should be undertaken in order to make possible the design of such ecological urban communities.

**Keywords:** *sustainable communities, eco-exurban, Carbon Free Cities Egypt.*

## 1 Introduction

The main concept of this research work is to address two of the existing and insurmountable problems that exist in Egyptian urban societies today; **overcrowding and pollution**. This is a continued research work carried out by the EDRG (Environmental Design Research Group) at the AAST (Arab Academy for Science and Technology). The research group looks at Sustainable and Environmental design techniques applied in urban developments and alternative energy sources. According to statistics published by CAPMAS (Central Agency for Public Mobilization and Statistics) on January 1<sup>st</sup>, 2006, Egypt's total population was estimated at approximately 73,671,661 people. In addition, the population growth rate has reached a rapid 1.91%. Although this problem is visible in all villages, towns and cities of Egypt, it continues to be a growing crisis in the capital city of Cairo. Many studies have been conducted to explore the reasons of such overcrowding, and it is now common knowledge that one of the main reasons for this problem is the migration of settlers from rural areas far and wide, as well as the commuting of workers from nearby towns and villages. These workers who are often poor, illiterate and unskilled, flood into larger, more urban cities such as Cairo and Alexandria, hoping to find a more promising lifestyle. However, due to their minimal incomes and low standards of living, they tend to flock together in cramped, undeveloped and dense urban settlements on the outskirts of the city, where conditions are poor, utilities non-existent and crime is rife.

The result of this overcrowding is the unplanned growth of cities in all directions, and the random-expansion of urban areas into nearby farm land, decreasing the already limited agricultural soil in the Nile Delta and Valley. As a result, a population of approximately 73 million people are now cramped on 5% of the total Egyptian land area. Over the years, several researchers have offered proposals in an attempt to solve some of these growing problems. One of those researchers is Professor Farouk Elbaz (Al-Ahram Weekly, 2006), who suggested that a superhighway is created along side the Western Desert, from *El-Alemein* on the Mediterranean, to Abu Simbel in the South of Egypt (Farouk El-Baz, 2007). Furthermore, he has proposed setting up additional towns and cities along this superhighway, in order to encourage development away from the already overpopulated cities and encourage the utilisation of the Western Desert. Therefore, allowing the spread of urban clusters to take place further away from the strip along the Nile Delta. As a result, this will decrease the levels of pollution in our cities and ensure a living place for all those who might be in danger of global warming and climate change.

Another major problem facing Egypt and the whole world now that requires an urgent solution and alternative urban developments away from the Delta that is at risk, is global warming or climate change (United State Congress, 1993). This phenomenon is a direct effect of extra release of gases around the earth that traps the sun's heat leading to green house effect. One of the main reasons for

such a problem is the mal-usage of energy resources in urban developments that are mainly based on Carbon-based fuels (Cook, 1998).

Thus, if Prof. El-Baz project "Egypt's Western Desert Development Corridor (Farouk El-Baz, 2007)" is to be considered by the government as an alternative from disasters expected by climate change on the Delta, Urban Developments and communities there need to have strict building codes and regulations addressing ecological and sustainable issues in all aspects of the built environment. There are so many new communities being developed around Cairo and Alexandria but these developments depends mainly on Carbon-based fuels and will act more as a global burden releasing more and more CO<sub>2</sub> increasing the green house effect.

The EDRG (Environmental Design Research Group) is committed to investigating the possibility of creating an exurban settlement at a specific location along this superhighway as an eco-exurban settlement and in continuation of Elbaz's proposal. One of the main aims is exploring the needs of a modern Ecological urban settlement in the desert, and therefore trying to reach optimum solutions for urban planning as well as the architectural design of building types and Eco-houses that will be developed.

Additionally, the paper addresses the possibility of utilising renewable energy resources, such as solar and hydropower energies, both of which are in abundance in our region, in order to promise a pollution-free and Zero carbon cities ZCC (Sara Hart, 2007; Oliver Lowenstein, 2001) for future generations in our region. Solar and wind power -- some of the most readily available renewable energy sources -- and emission free -- are grossly underutilized worldwide. To quote the world-renowned architect Lord Norman Foster, "The challenge (was) to relate the new building to the old, but at the same time to create a building that represent (ed) its own age with integrity." – Foster and Partners, Carre d'Art, Nimes. This quote is merely applicable to the aims and objectives of this research work, but on larger urban scale.

The proposed WDDC includes sustainable and eco- exurban communities which are net producers of energy, food, clean water and air, beauty, and healthy human and ecological communities. Overcrowding and over-pollution are the main problems that affect all sectors of Egyptian society. However, it is important to note that, poor, illiterate and unskilled members of society contribute a great deal to these problems, as they continue to migrate and commute daily from rural and less industrial areas to larger more urban and already congested cities. This project aims to tackle those main problems by giving them a chance to migrate to newer and, perhaps, more promising exurban settlements that will be set up in the Western Desert region. This paper seeks to create and set a strategy for how cities on Egypt's Western Corridor can develop carbon neutrally and on a Zero Energy Basis.

Some parts of these settlements serve the poor and ensure them a different, more wholesome lifestyle. The proposed new-settlements may give the poor a better chance in life by means of different environmental, energy efficient, and sustainable architecture techniques which will be primarily built for their use. Local construction materials and implementing developed-natural passive lighting and cooling techniques inspired from our inherited architecture identity and many of our reputable Egyptian Architects like Hassan Fathy (B. Givoni, 1976; James Steele, 1988) and Abdul Wahed ELWakeel who are imperative for such eco-exurban communities.

However, natural passive techniques have to be technologically innovatively designed like light pipes and natural vents. The proposed designs must also use local materials to be attractive, affordable and healthy in order to give this sector of society a sense of hope, encouraging their migration out of their current cities. In order to reach these optimum/sustainable solutions and give insight into what/how the optimum exurban community and new environment will be, new ecological criteria for the design and application of these settlements should be done.

## **2 Sustainable Exurban Development Schemes for the Western Desert of Egypt**

The main concept of this research work and project is to put forward number of integrated Sustainable Exurban Development Schemes SEDS and strategies for the Western Desert Development Corridors of Egypt. This project primarily goal is to lessen the harm *poorly designed buildings* in cities like Cairo and Alexandria has caused by using the best of ancient building approaches or vernacular approaches in logical combination with the best of new technological advances such as smart, intelligent materials and renewable resources and technologies.

SEDS proposes number of sustainable and eco-exurban settlements that may take place alongside the strip of the superhighway of the WDDC which has been proposed by Prof. Farouk Elbaz. The main idea around the project is to elaborate Elbaz's proposed research from twenty five years ago, in order to produce an urban-proposal and architectural approach for the suggested extensions. Elbaz's proposal has recommended the development of a new Superhighway (Infrastructure- Development Corridor parallel to the Nile, on which most of the Egyptian towns and cities are congested shown in Fig. 1.

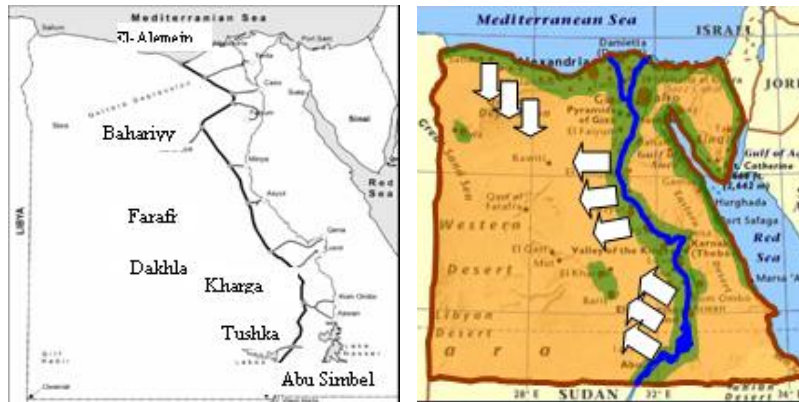


Figure 1: The proposed SEDS and western desert development corridors (a. courtesy of Al-Ahram weekly online)

According to this proposal, this should be the start of the development of new exurban settlements along side the superhighway that can be the new home for many who think of moving to crowded jammed areas. This, therefore, will help reduce the overcrowding and pollution levels in major cities such as Cairo and Alexandria in the north, and Al Minya and Assiout in the South. Fig. 1 depicts the possibilities of exurban future extensions and development schemes.

### 3 Conceptual Designs and Sustainable Approach

During the urban-design phases, the proposed research project should aim to specify a certain location alongside this strip and put forward an exurban design proposal for optimum sustainable urban settlements. Energy efficient, environmental designs should be proposed on every scale, whether urban or architectural. Physical 3D models of urban-designs must be created and monitored in environmental laboratories, and judged comparatively, which will enable the researchers to determine the optimum sustainable solution out for eco-exurban communities at Egypt's western desert. Furthermore, the proposed future exurban communities should form a built-environment that massively and constructively relies upon renewable energy sources, local materials and local climate which are readily available in our country. Therefore, employing several renewable-energy technologies to create a clean, green and sustainable exurban built environment.

The intended built environment is crucial for ensuring health and safety of our children and further generations to come. The proposed exurban communities should also at one hand reflect our vernacular heritage. On the other hand fits today's modern urban and architectural technology and, at the same time, becomes a whole new work-live environment, rather than just an area where people can commute to.

The term "sustainable" communicates slightly different meanings to various audiences and it seems as a complicated term to others. The verb "sustains" means to support, to keep alive, or to keep going continuously. "Sustenance" is the process of sustaining life and the adjective "sustainable" is used to describe an object that gives continuous support and relief (**Boake**, 1995). Sustainability in urban and architecture is not a "topic" but an "attitude". It is a process of responsible consumption, wherein waste is minimised, urban communities interact in balanced ways with natural environments, balancing the desires and activities of humankind and finally, achieving a stable long-term relationship within the limits of their local and global environments (**Cook**, ; Oscar Faber et al., 1997).

After those definitions and even after further discussions, which are included in this paper and the following design-phases, numerous questions are still in need of definitive answers. What are the most practical and most effective means to begin with? What strategies are most critical for architects and their designs? What strategies are most suitable to provide energy efficient designs, low/zero-carbon buildings? What do urban communities have to do? What should be done to promote sustainability on urban scale? Sustainable urban as an approach is the practice of designing communities that create more desirable living environments with the minimum use of non-renewable energy and natural resources.

It is very important to address the issue of sustainability in modern urban communities and buildings. Sustainable urban is an operating concept that provides "sustenance" to users through healthy and environmentally friendly built environments, thus improving the life quality towards a long-term survivability of human generations and their natural resources. Building materials and designs, infrastructure, transportation, and post-operating systems, (*such as heating, cooling and power*) have a great role towards providing such built-environment. "Sustainable" in other words, creates urban forms that harmonise with its environment and surroundings as naturally as possible.

Steven Strong stated, "The term is intellectually dishonest", and the society does not know exactly how to build a sustainable urban communities, Dick Levine went further and stated that the term "sustainable urban or architecture" is an oxymoron" (**Minke**, 2000). The United Nations lists the main principles of sustainable built environment as the following (**Barnett & Browning**, 1995):

1. Healthful Interior Environment
2. Resources Efficiency
3. Ecologically Benign Materials
4. Environmental Form
5. Proper Design

Therefore, the better architects understand and implement their stewardship of the built environment, the better the quality of life that present and future generations will enjoy. Such a movement needs environmentally sensitive planners, urban-designers, and architects who are able to integrate different

environmental-responsive concepts into their final products and designs effectively. A clear overview of the conflict between desert-harsh climatic conditions and urban communities at Egypt's western desert need to be analysed and summarised in order to clearly deal with it. It also explains the eco-exurban and other sustainable concepts intended to be suitable and practical solutions that can effectively lessen the world's environmental damage. The proposed exurban communities should illustrate that sustainable urban approaches can also lead to reviving the missing architectural/urban character and identity of such regions, which traditionally were able to cope with the harsh climatic conditions of tropical and hot-arid areas and provides a character of space.

The communities should discuss the possible practical solutions of relying on passive techniques to provide sustainable and ecological urban communities. Thereby, lowering consumption of non-renewable energy resources and consequently lessening the outcome pollutants, which cause the existing environmental damage (United State Congress, 1993). Many of today's urban communities MUST be considered environmental destroyers as in the schematic diagram shown in Fig. 2.



Figure 2: High-population urban communities, built environment and non-renewable resources

#### 4 Technical and Methodological Approaches

The current attempts and practices of creating sustainable designs work within a range of green strategies including and not limited to, passive or active solar design, wind technologies and passive cooling or heating designs. Architects should learn to generate new sustainable typologies from the climate formed from traditional vernacular buildings. Many modern passive design technologies have learned to build upon the climatic responsive methodology that was found in vernacular and traditional buildings.

The sought approach is not only towards more sustainable urban and environment, but also to create an urban identity, which is recently missed. *Charles Correa said: "We have to know from where we are coming to know where we are going"* (Tillman Lyle, 1994). Climate conscious design is considered as one of the sustainable urban and architecture promoters. Fig (3) clarifies a schematic diagram of the sequence of a sustainable design process.

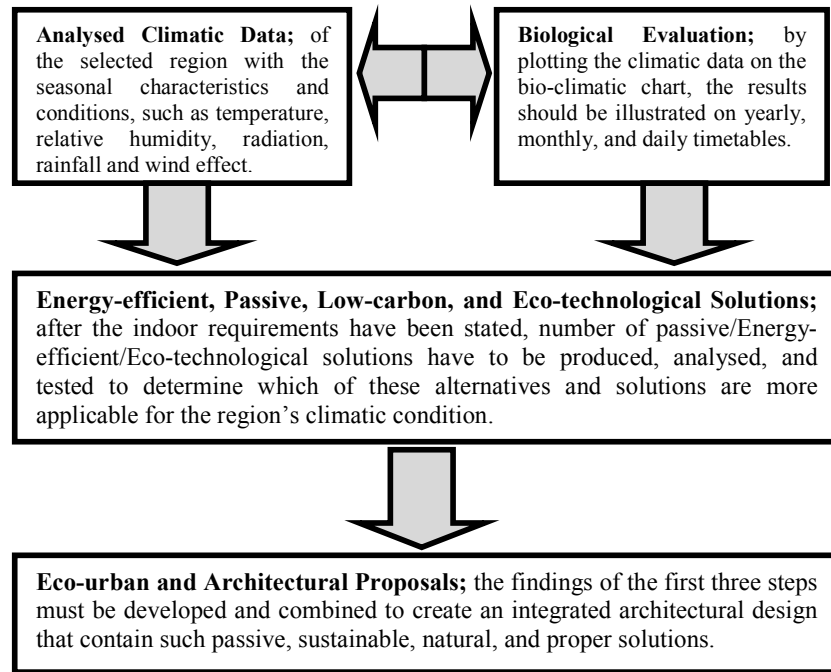


Figure 3: Methodological Approach of the Proposed Sustainable and Eco-exurban Communities

Following this methodological approach and urban-design formation, the task at hand is to experiment and investigate energy efficient, environmental building envelopes for a new urban community (a prototype), situated at a certain location chosen by the research-team on Elbaz's superhighway (Farouk El-Baz, 2007) in the Egyptian Western Desert region. These new communities should act towards providing number of nodes for progressive and attractive exurban settlements and a base for Carbon Free Cities or Zero Energy Settlements not only for rural migrants and workers but also for more professional people who aims at a healthier better life style to move to. Therefore, they strategically prevent overcrowding and increased levels of pollution in larger, more urban cities such as *Cairo, Alexandria, Aswan, and Al-Minya*.





Figure 4: Probable-Traditional Urban Forms for the Newly Proposed Eco-exurban Communities in Egypt

The proposed sustainable urban communities are to be designed as green, sustainable, energy efficient and environmentally friendly communities, designed using successful vernacular elements of our traditional architecture and urban communities using modern techniques as mentioned earlier in this paper. In order to pursue the proposed exurban communities accurately and comprehensively, the technical approach aims at employing computational and experimental environmental investigations for both urban-designs and forms. Therefore, the urban layout of the community has to be based on a certain specified population. The architectural and urban design proposals should take into consideration the followings:

- The layout of urban forms and buildings, in view of the contextual, social, cultural and economic aspects as well as the climatic nature of the chosen area.
- The investigation of building envelopes (optimum form, texture and orientation) and design of buildings in such a way that a minimum amount of energy is utilized, as well as taking advantage of the abundant renewable energy resources available (solar energy and wind power) using physical modeling techniques and CFD (computational Fluid Dynamics).
- The employed construction materials availability, cost and whether or not the final product can be integrated within the context and environment of Egypt's Western Desert.
- Renewable energy resources and technologies and the infrastructure arrangements.

It is also important that, for each of the aforementioned points, several design alternatives are to be produced to facilitate finding the optimum solutions for the conditions of Egypt's Western Desert Corridor (considering that the optimum design will change according to placement north or south of the Corridor due to different weather conditions. In order to find out the optimum solution, comparative analysis of these urban-design solutions must take place, under two main aspects.

#### **4.1 Quantitative Methodological Aspects**

In order to monitor these exurban designs quantitatively, specific simulation software's are to be used for the environmental investigations, primarily CFD software's will be used such as Fluent or Apache. In addition, physical 3D models will be built and monitored for renewable architectural elements (Light pipes, natural vents- Natural passive lighting and cooling techniques developed from our inherited architecture identity) in environmental laboratories (environmental chambers, wind tunnels) with a similar/simulated environment to that of the Western Desert. The results simulated using CFD techniques will be validated using the results of the physical modeling. After validation computational simulation will facilitate testing more complex alternatives at less time and effort, giving optimum solutions with efficient results.

#### **4.2 Qualitative Methodological Aspects**

The aspects which explore the cultural, social, contextual, political and economic issues of each design solution. This should be thoroughly analyzed followed by a complete urban report on all the different aspects pulling the line to a conclusion.

### **5. Recommended Framework**

There are many different aspects that need to be measured, whether comparatively or individually. Each one of these aspects will be given a certain percentage but, it is important to note that each one of these aspects will have a different grade due to the differences in the nature of the issues. The following percentages will generally be correct, but not extremely precise/accurate. If numbers do change, the differences will only be slight. This is because, at early design stages, it is difficult for the researchers to determine the exact weight of each item/issue, and the percentages that have been generated come from the researchers' general knowledge and basic understanding of the urban project as well as of the nature of the context that is being dealt with.

Directly upon/ after conducting site analysis of the WDDC and reaching conclusions for main potential and constraints for the choice of the exact location, number of actions and milestones have to take place as follows;

- Form a detailed site analysis report along with final objectives considerations and design principles.
- Figure out an urban proposal considering all potentials and constraints, and thus give way to several design proposals on the urban scale.
- Conduct a comparative judgment of the urban design proposals in order to find out the optimum solutions based on both qualitative and quantitative analysis of findings.

- Carry out a sustainable investigation for building materials and their proper implementation in buildings.
- Designing architectural elements as natural passive lighting and cooling techniques developed from our inherited architecture identity. These are designed using modern techniques such as light pipes and natural vents. Illustrating several design solutions for the architectural design of buildings putting into consideration the above designed vocabularies. Focus will be placed on the layout of buildings from both a functional and contextual viewpoint.
- Determine the most suitable materials that should be used to erect the buildings, CFD simulations and physical modeling and monitoring will take place. Comparative judgment of these solutions will take place, giving the researchers insight into which designs will be most suitable for the Western Desert context.
- After both optimum urban layout and architectural design formation, research into alternate technologies of energy generation must take place. Solar energy and wind power are in abundance in Egypt, therefore, the research project aims to rely on these forms not only to serve the new urban community, but to be used in all parts of Egypt, trying to fulfill the governments aims to supply 14% of Egypt's electricity by renewable energy by the year 2020 (NREA - New and Renewable Energy Authority - Egypt Country Study, 2001; REN 21 Renewable Energy Policy Network for the 21st Century, 2007).
- Finally, a final complete urban development scheme to be generated along with building design proposals. Technical and detailed reports on types of used-materials and all other urban and architectural features have to be carried out.

## 6 Conclusion and Future Enhancement Actions

Apart of the monetary and funding resources, the success of WDDC research proposal has to be viewed and measured from a qualitative point of view; such social and cultural behaviors, architectural and urban identities, and life-quality. Other quantitatively measured aspects must be taken into consideration; such national benefit, sustainable development and climatic considerations, development of passive urban and architectural elements, economical development, and renewable energy resources. Therefore, the success of the research proposal presented in this paper can be guaranteed if certain standards are met, from social, cultural and economic points of view.

In order to ensure this level of success, studies and investigations must be performed as a prerequisite to creating Zero Energy urban community. Traditions, culture and behavior must all be accurately measured and tested, questionnaires and interviews conducted, to understand all these aspects, so that they can be dealt with appropriately. Only when this is done will it be possible

for the researchers to design, not only settlements, but a whole work-live environment where people will not only migrate, but transfer their lives to.

As for the environmental performance issues, these will be measured quantitatively in two different ways:

- Physical 3D models of the architecture passive elements and vocabularies developed and the design proposals will be built. These will be placed in environmental laboratories and monitored continuously. Temperatures and other data will be recorded, so that each of these design proposals can be judged comparatively. In this way, the optimum design solution out of all the proposals can be chosen.
- Computer-generated models will also be created using specific simulation software, mainly CFD (computer fluid dynamics.) This software will easily ensure accurate results and thus, it will be possible for the researchers to determine the optimum solution of all the design proposals.

The final conclusion is that the Egyptian building code for the new developments and settlements in Egypt needs to be changed. The change need to address the Architectural character, sustainability issues and energy performance of buildings. We cannot propose a project like Egypt's Western Corridor and keep on building these massive concrete boxes that is mainly run by Carbon-Based fuels that is a main cause of global warming and climate change that has no specified architecture character and reflects nothing of our rich heritage.

## **7 Recommendations**

Designing Egypt first Carbon Free City and Zero Energy Development on Western Development Corridor. Setting NGO's, committees and associations asking for our right and the right of generations to come to live in a clean, unpolluted environment. Massive programs that target raising the awareness of the Egyptian public society (local awareness), on ALL levels and not just direct users should be developed. WE need to MARKET and PROMOTE Renewable Energy Technology to be used in Egypt and the benefits people, Government, and Country will reap from in return.

In order to widen the circle of PV/wind and other Renewable Energy usages in Egypt, it is important, that decision-makers should be fully aware about other countries successful projects in this area and how much societies, countries, economy, & people can benefit from their application.

Finally, a rewarding and encouraging Strategy has to be followed in order to promote the mass-usage of Renewable Energy Technology in Buildings & new urban communities.

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